ISE 307: Engineering Economic Analysis

Lecture 21: Depreciation (Ch 9)

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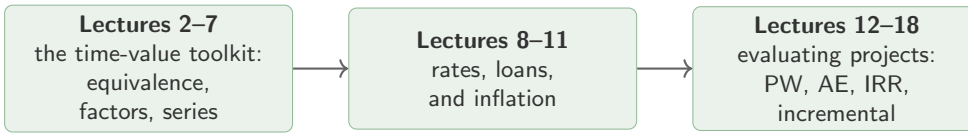
Lecture 21

From Cost Basis to Book Value:
Allocating an Asset's Cost over Its Life

Lecture 21 Objectives

1. Identify **depreciable property**; compute **cost basis** and **book value**
2. Distinguish **book** depreciation from **tax** depreciation
3. Build **straight-line** (SL) and **units-of-production** (UoP) schedules
4. Build **declining-balance** (DB): α, **salvage floor**, **switch to SL**
5. Apply **MACRS**: classes, 1/2-year convention, percentage tables

Where We Are in the Course



Everything so far shares two simplifications: every cash flow was **pre-tax**, and every input was a single **point estimate** (certain).

Part 3: Advanced Topics

lectures	layer	the fact it adds
21–22	**depreciation and taxes**	real projects pay tax on income
23	**uncertainty**	estimates can be wrong
24	**replacement**	assets age and must be retired

The tools do **not** change: PW and AE still decide. The three layers change the *cash flows* that go into them.

What Can Be Depreciated?

Depreciation = the systematic allocation of an asset's cost over its *depreciable life*. It is a **non-cash** accounting charge — no money leaves the firm when it is recorded.

- **Depreciable property** must: (1) be used in business or held to produce income; (2) have a definite service life **longer than one year**; (3) wear out, decay, get used up, or become obsolete
- Qualifies: buildings, machinery, equipment, vehicles, some intangibles
- Does **not** qualify: **land** (no definite life); **inventories** (held for sale)

Cost Basis and Book Value

The **cost basis** I = everything needed to place the asset *in service*.
For example:

Purchase price	46,000 SAR
Freight	1,200
Site preparation	1,300
Installation	1,500
Cost basis I	**50,000 SAR**

Book value after year n: $B_n = I - (D_1 + D_2 + \cdots + D_n)$ — cost basis minus *accumulated* depreciation.

To depreciate, we need: (1) cost basis I, (2) salvage value S, (3) depreciable life N, and (4) a **method**.

Book vs. Tax Depreciation

Book depreciation

- for **finance reports** and **pricing**
- match the asset's loss of value
- methods: **SL, DB, UoP**

Tax depreciation

- for computing **income taxes**
- mandated by the tax authority: the U.S. uses the **Modified Accelerated Cost Recovery System (MACRS)**
- *accelerated*: earlier = larger

Total depreciation is the **same** in both (only the **timing** differs).
Accelerated depreciation defers taxes, and earlier money worths more.

Straight-Line (SL) Depreciation

SL spreads the depreciable amount evenly:

$$D_n = \frac{I - S}{N} \quad \text{every year (rate} = 1/N\text{)}.$$

The flotation cell: $I = 50{,}000$ SAR, $S = 5{,}000$, $N = 5$:

$$D_n = \frac{50{,}000 - 5{,}000}{5} = 9{,}000 \text{ SAR/yr}$$

year n	0	1	2	3	4	5
D_n	—	9,000	9,000	9,000	9,000	9,000
B_n	50,000	41,000	32,000	**23,000**	14,000	5,000

Book value falls along a straight line and ends exactly on $S = 5{,}000$.

Declining-Balance (DB) Depreciation

DB charges a **fixed fraction α of the remaining book value**:

$$D_n = \alpha\, B_{n-1}, \text{ with } \alpha = \frac{\text{multiplier}}{N}.$$

Multiplier 2.0 $\Rightarrow$ **double declining balance (DDB)**:

$$\alpha = 2/N.$$

The flotation cell is under double declining balance: $\alpha = 2/5 = 40\%$:

n	$D_n = 0.40\, B_{n-1}$	B_n
1	$0.40 \times 50{,}000 = 20{,}000$	30,000
2	$0.40 \times 30{,}000 = 12{,}000$	18,000
3	$0.40 \times 18{,}000 = 7{,}200$	10,800
4	$0.40 \times 10{,}800 = 4{,}320$	6,480
5	$0.40 \times 6{,}480 = 2{,}592$? **No: capped at 1,480**	**5,000**

Switching from DB to SL

If S is low, DB **never reaches** it. A 10,000 asset ($N = 5$, $S = 0$): pure DDB leaves $B_5 = 778$, undepreciated.

Switching rule: in each year, compare DB with SL on the *remaining* balance, $D_n^{SL} = \dfrac{B_{n-1} - S}{\text{remaining years}}$; once SL is larger, switch and stay.

n	DDB	SL on remainder	taken
1	4,000	2,000	4,000
2	2,400	1,500	2,400
3	1,440	1,200	1,440
4	864	**1,080**	**1,080 (switch)**
5	—	1,080	1,080

Total = 10,000: fully depreciated. MACRS builds this switch in.

Units-of-Production (UoP) Depreciation

UoP spreads $I - S$ in proportion to **usage**, not time:

$$D_n = \frac{\text{service units consumed in year } n}{\text{total service units}} (I - S)$$

An ore-transfer truck: $I = 80{,}000$ SAR, $S = 8{,}000$, rated for **200,000 km**; driven **35,000 km** this year:

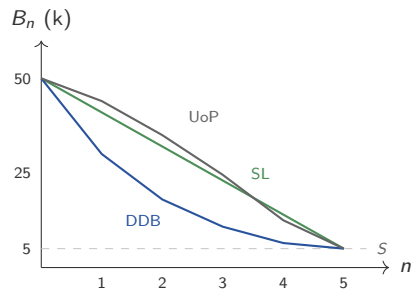
$$D = \frac{35{,}000}{200{,}000} (80{,}000 - 8{,}000) = 0.36 \text{ SAR/km} \times 35{,}000 = \boxed{12{,}600 \text{ SAR}}$$

Use UoP when **usage drives the wear**: vehicles (km), machines (hours), presses (cycles). A slow year means a small charge.

Depreciation Methods Comparison

The flotation cell ($I = 50{,}000$, $S = 5{,}000$, $N = 5$) processes 20, 30, 35, 40, 25 thousand tonnes (total 150,000 t $\Rightarrow$ 0.30 SAR/tonne):

	SL		**DDB**		**UoP**	
n	D_n	B_n	D_n	B_n	D_n	B_n
1	9,000	41,000	20,000	30,000	6,000	44,000
2	9,000	32,000	12,000	18,000	9,000	35,000
3	9,000	23,000	7,200	10,800	10,500	24,500
4	9,000	14,000	4,320	6,480	12,000	12,500
5	9,000	5,000	1,480	5,000	7,500	5,000
Σ	**45,000**		**45,000**		**45,000**	



Same total (45,000) and end, but different trajectory.

MACRS: The Tax Side

Under **MACRS**, every asset falls into a **property class** (its *recovery period*):

class	examples
3-year	special manufacturing tools
5-year	automobiles, light trucks, computers, high-tech gear
7-year	most manufacturing equipment, office furniture
10-year	vessels, barges, long-lived equipment
27.5 / 39-year	residential rental / commercial buildings (**SL only**)

MACRS rules for personal property: **salvage** $= 0$ **always**; DDB with the **built-in switch to SL**; and the **half-year convention** — only a half-year charge in year 1, so an N-year class spans $N+1$ tax years.

MACRS Percentage Tables (Half-Year Convention)

The tax authority publishes the resulting **recovery allowance percentages**; the charge is just $D_n = I \times p_n$:

year n	3-year	5-year	7-year
1	33.33%	20.00%	14.29%
2	44.45%	32.00%	24.49%
3	14.81%	19.20%	17.49%
4	7.41%	11.52%	12.49%
5		11.52%	8.93%
6		5.76%	8.92%
7			8.93%
8			4.46%

Each column sums to 100%.

MACRS Example: 5-Year Property

Consider a bagging equipment: cost basis **25,000 SAR**, 5-year MACRS class.
$D_n = 25{,}000 \times p_n$:

n	p_n	D_n	B_n
1	20.00%	5,000	20,000
2	32.00%	8,000	12,000
3	19.20%	4,800	7,200
4	11.52%	2,880	4,320
5	11.52%	2,880	1,440
6	5.76%	1,440	0
	100%	**25,000**	

Early-disposal rule: sold during the recovery period $\Rightarrow$ only **half** of that year's charge.
Sold in year 2: $D_2 = 8{,}000/2 = 4{,}000$.

Practice Problem 1

(a) A filling machine: cost basis **90,000 SAR**, salvage **10,000 SAR**, life **8 years**, **straight-line** depreciation. Find the annual charge D and the book value at the end of year 5.

(b) Lab equipment: cost basis **60,000 SAR**, life **5 years**, **double-declining-balance** depreciation. Find the year-2 charge D_2.

Practice Problem 1: Solution

(a) SL charge and book value:

$$D = \frac{90{,}000 - 10{,}000}{8} = 10{,}000 \text{ SAR/yr}$$

$$B_5 = 90{,}000 - 5 \times 10{,}000 = \boxed{40{,}000 \text{ SAR}}$$

(b) DDB rate: $\alpha = 2/5 = 40\%$:

$$D_1 = 0.40 \times 60{,}000 = 24{,}000 \;\Rightarrow\; B_1 = 36{,}000$$

$$D_2 = 0.40 \times 36{,}000 = \boxed{14{,}400 \text{ SAR}}$$

Summary

- **Cost basis** I = everything to place the asset in service; **book value** $B_n = I -$ accumulated depreciation. Land is never depreciated
- **Book** depreciation (SL, DB, UoP) reports; **tax** depreciation (MACRS) is mandated. Same total, different *timing*
- **SL**: $D_n = (I - S)/N$. **UoP**: proportional to usage
- **DB**: $D_n = \alpha B_{n-1}$, $\alpha =$ multiplier$/N$ (DDB: $2/N$); **never below** S (floor); **switch to SL** to reach a low S
- **MACRS**: class $\Rightarrow$ table; $D_n = I \times p_n$; salvage $= 0$; **half-year convention** (N+1 tax years; half charge in a disposal year)

Before Class

To do before our class meeting:

1. **Read Sections 9.1–9.2** (depreciable property, cost basis, SL/DB/UoP) and skim **9.3** (MACRS)
2. Complete the **Lecture 21 pre-class quiz** on Blackboard before class
3. Warm-up: SL on $I = 40{,}000$, $S = 4{,}000$, $N = 6$ — find D and B_2